



COURSE OUTLINE

1. **Course:** PHYS 543, Quantum Mechanics II - Fall 2022

Lecture 01 : MWF 10:00 - 10:50 in ST 063

Instructor	Email	Phone	Office	Hours
Dr Daniel Oblak	doblak@ucalgary.ca	403 220-7660	SB 313	Fri. 1:30-2:30 pm (may be adjusted to better fit student schedules)

To account for any necessary transition to remote learning for the current semester, courses with in-person lectures, labs, or tutorials may be shifted to remote delivery for a certain period of time. In addition, adjustments may be made to the modality and format of assessments and deadlines, as well as to other course components and/or requirements, so that all coursework tasks are in line with the necessary and evolving health precautions for all involved (students and staff).

In Person Delivery Details:

There are three nominal class times per week for this course. The Wed and Fri class times will be dedicated to lectures while the Mon class times will be dedicated to follow-up lectures, home-work review, problem-solving, independent term project work, office hours, and the midterm according to the posted schedule.

Re-Entry Protocol for Labs and Classrooms:

To limit the spread of COVID-19 on campus, the University of Calgary has implemented safety measures to ensure the campus is a safe and welcoming space for students, faculty and staff. The most current safety information for campus can be found [here](#).

Course Site:

D2L: PHYS 543 L01-(Fall 2022)-Quantum Mechanics II

Note: Students must use their U of C account for all course correspondence.

Equity Diversity & Inclusion:

The University of Calgary is committed to creating an equitable, diverse and inclusive campus, and condemns harm and discrimination of any form. We value all persons regardless of their race, gender, ethnicity, age, LGBTQIA2S+ identity and expression, disability, religion, spirituality, and socioeconomic status. The Faculty of Science strives to extend these values in every aspect of our courses, research, and teachings to better promote academic excellence and foster belonging for all.

The Physics and Astronomy EDI Committee acknowledges there are persistent barriers that prevent such accessibility and hinder our progress towards EDI. Our representatives (faculty, postdocs, graduate and undergraduate students) are committed to addressing any concerns and work towards proactive solutions that enact necessary change within the department. To submit anonymous questions, comments or concerns regarding EDI related issues, please reach out to our Associate Head EDI, Claudia Gomes da Rocha (claudia.gomesdarocho@ucalgary.ca)

2. **Requisites:**

See section [3.5.C](#) in the Faculty of Science section of the online Calendar.

Prerequisite(s):

Physics 443.

3. **Grading:**

The University policy on grading and related matters is described in [F.1](#) and [F.2](#) of the online University Calendar.

In determining the overall grade in the course the following weights will be used:

Course Component	Weight	Due Date (duration for exams)	Modality for exams	Location for exams
Assignments ¹	30%	Ongoing		
Term project ²	20%	Ongoing		
Midterm	15%	Oct 24 2022 at 10:00 am (50 Minutes)	in-person	In class ST063
Registrar Scheduled Final Exam	35%	Will be available when the final exam schedule is released by the Registrar	in person	Will be available when the final exam schedule is released by the Registrar

¹ Due dates to be published

² Term project delivered during class times (final three)

Each piece of work (reports, assignments, quizzes, midterm exam(s) or final examination) submitted by the student will be assigned a grade. The student's grade for each component listed above will be combined with the indicated weights to produce an overall percentage for the course, which will be used to determine the course letter grade.

The conversion between a percentage grade and letter grade is as follows.

	A+	A	A-	B+	B	B-	C+	C	C-	D+	D
Minimum % Required	95 %	90 %	85 %	80%	75%	70 %	65 %	60%	55%	50 %	45 %

The final grade percentage will not be rounded up before conversion to a letter grade according to the conversion table.

This course will have a Registrar Scheduled Final exam that will be delivered in-person and on campus. [The Final Examination Schedule](#) will be published by the Registrar's Office approximately one month after the start of the term. The final exam for this course will be designed to be completed within 2 hours.

Homework

Homework assignments are to be handed in according to the schedule (approximately every 2nd week), which will be announced on the course website with at least one week notice for any changes to the schedule. Homework must be submitted via the course website (Dropbox) on D2L. There are no homework-assignments during the first week of classes, reading-week, midterm week, and final exam week.

Homework assignments handed in late without prior agreement with instructor will receive a score reduction of 25% if handed within 24 hours of the due date and a score reduction of 50% if handed in before time that the home-work solutions are made available.

Term project - PHASQ 2022 Conference

The term project will emulate a scientific conference at which participants will give presentations covering a scientific research article. The presentations will be given in the final week(s) of the term at the "PHASQ 2022" conference. The conference will feature poster presentations and a limited number of talks. Whether participants give a talk or present a poster will depend on their preference indicated in the conference registration form as well as the Program and Selection Committee's (described below) assessment of the abstract. Participants at the conference can be individual students or teams of two students. The venue for the conference will be announced during the term.

The term project presentations must be based on a detailed review and synopsis of a research paper in a topic related to the course material. Students are encouraged to suggest research papers, which must be approved by the instructor. A list of suitable papers will be posted on D2L during the start of the term.

In addition to the giving a presentation all students will be involved in one of two committees (each consisting of half of the students in the class). The "Program & Selection Committee" will review and score the submitted abstracts, based on which the presentations are assigned to be given as talks or poster presentations. The "Awards Committee" will evaluate and score the talks and poster presentations in order to determine the best talk and poster presentation, which will both receive an award. Besides the honour the winners of the presentation in each category will have their final exam be weighted extra - 5% additional weight for talk winner and 3% extra weight for the poster presentation winner. These extra weights will be added as bonus such that the final percentage exceeds 100% for the winners. As an example if the winner of the best talk scores 30/35 - > 85.7% on the final the bonus will mean that the final grade will be calculated as $(0.35 + 0.05) \times 85.7\%$ instead of $0.35 \times 85.7\%$.

The weight of the term project for the final grade is 20%. The grade for the term project will be assigned as follows:

- 5% for completing the abstract submission according to the requirements. Deductions of 0.5% will be made for each criterion that is not fulfilled.
- 2% for completing the committee duties, i.e., filling out the evaluation of abstracts or presentations for the program and award committees, respectively.
- The remaining weight will be assigned according to the quality of the presentations. This evaluation will be done by the instructor following the same evaluation rubric as used by the awards committee. A perfect evaluation will result in 13% and a missing presentation to 0%.

The University of Calgary offers a [flexible grade option](#), Credit Granted (CG) to support student's breadth of learning and student wellness. Faculty units may have additional requirements or restrictions for the use of the CG grade at the faculty, degree or program level. To see the full list of Faculty of Science courses where CG is not eligible, please visit the following website: <https://science.ucalgary.ca/current-students/undergraduate/program-advising/flexible-grading-option-cg-grade>

4. **Missed Components Of Term Work:**

The university has suspended the requirement for students to provide evidence for absences. Please do not attend medical clinics for medical notes or Commissioners for Oaths for statutory declarations.

In the event that a student legitimately fails to submit any online assessment on time (e.g. due to illness etc...), please contact the course coordinator, or the course instructor if this course does not have a coordinator to arrange for a re-adjustment of a submission date. Absences not reported within 48 hours will not be accommodated. If an excused absence is approved, one possible arrangement is that the percentage weight of the legitimately missed assignment could also be pro-rated among the components of the course. This option is at the discretion of the coordinator and may not be a viable option based on the design of this course.

5. **Scheduled Out-of-Class Activities:**

There are no scheduled out of class activities for this course.

6. **Course Materials:**

Required Textbook(s):

David J. Griffiths and Darrell F. Schroeter, *Introduction to Quantum Mechanics, 3rd Edition*. Cambridge University Press.

Additional notes may be provided.

In order to successfully engage in their learning experiences at the University of Calgary, students taking online, remote and blended courses are required to have reliable access to the following technology:

- A computer with a supported operating system, as well as the latest security, and malware updates;
- A current and updated web browser;
- Webcam/Camera (built-in or external);
- Microphone and speaker (built-in or external), or headset with microphone;
- Current antivirus and/or firewall software enabled;
- Stable internet connection.

For more information please refer to the UofC [ELearning](#) online website.

7. **Examination Policy:**

All exams are intended to be completed individually.

Midterm exam will be delivered during the regular class time on October 24. Any accommodations, e.g. extended time, will be calculated from the 50 minutes class duration.

The final exam will be scheduled by the registrar.

Students should also read the Calendar, [Section G](#), on Examinations.

8. **Approved Mandatory And Optional Course Supplemental Fees:**

There are no mandatory or optional course supplemental fees for this course.

9. Writing Across The Curriculum Statement:

For all components of the course, in any written work, the quality of the student's writing (language, spelling, grammar, presentation etc.) can be a factor in the evaluation of the work. See also Section [E.2](#) of the University Calendar.

10. Human Studies Statement:

Students will not participate as subjects or researchers in human studies.

See also [Section E.5](#) of the University Calendar.

11. Reappraisal Of Grades:

A student wishing a reappraisal, should first attempt to review the graded work with the Course coordinator/instructor or department offering the course. Students with sufficient academic grounds may request a reappraisal. Non-academic grounds are not relevant for grade reappraisals. Students should be aware that the grade being reappraised may be raised, lowered or remain the same. See [Section I.3](#) of the University Calendar.

- a. **Term Work:** The student should present their rationale as effectively and as fully as possible to the Course coordinator/instructor within **ten business days** of either being notified about the mark, or of the item's return to the class. If the student is not satisfied with the outcome, the student shall submit the Reappraisal of Graded Term work [form](#) to the department in which the course is offered within 2 business days of receiving the decision from the instructor. The Department will arrange for a reappraisal of the work within the next ten business days. The reappraisal will only be considered if the student provides a detailed rationale that outlines where and for what reason an error is suspected. See sections [I.1](#) and [I.2](#) of the University Calendar
- b. **Final Exam:** The student shall submit the request to Enrolment Services. See [Section I.3](#) of the University Calendar.

12. Other Important Information For Students:

- a. **Mental Health** The University of Calgary recognizes the pivotal role that student mental health plays in physical health, social connectedness and academic success, and aspires to create a caring and supportive campus community where individuals can freely talk about mental health and receive supports when needed. We encourage you to explore the mental health resources available throughout the university community, such as counselling, self-help resources, peer support or skills-building available through the SU Wellness Centre (Room 370, MacEwan Student Centre, [Mental Health Services Website](#)) and the Campus Mental Health Strategy website ([Mental Health](#)).
- b. **SU Wellness Services:** For more information, see their [website](#) or call [403-210-9355](#).
- c. **Sexual Violence:** The Sexual Violence Support Advocate, Carla Bertsch, can provide confidential support and information regarding sexual violence to all members of the university community. Carla can be reached by email (syasa@ucalgary.ca) or phone at [403-220-2208](#). The complete University of Calgary policy on sexual violence can be viewed [here](#).
- d. **Misconduct:** Academic integrity is the foundation of the development and acquisition of knowledge and is based on values of honesty, trust, responsibility, and respect. We expect members of our community to act with integrity. Research integrity, ethics, and principles of conduct are key to academic integrity. Members of our campus community are required to abide by our institutional [Code of Conduct](#) and promote academic integrity in upholding the University of Calgary's reputation of excellence. Some examples of academic misconduct include but are not limited to: posting course material to online platforms or file sharing without the course instructor's consent; submitting or presenting work as if it were the student's own work; submitting or presenting work in one course which has also been submitted in another course without the instructor's permission; borrowing experimental values from others without the instructor's approval; falsification/fabrication of experimental values in a report. Please read the following to inform yourself more on academic integrity:

[Student Handbook on Academic Integrity](#)
[Student Academic Misconduct Policy](#) and [Procedure](#)
[Faculty of Science Academic Misconduct Process](#)
[Research Integrity Policy](#)

Additional information is available on the [Student Success Centre Academic Integrity page](#)

e. Academic Accommodation Policy:

It is the student's responsibility to request academic accommodations according to the University policies

and procedures listed below. The student accommodation policy can be found at: <https://www.ucalgary.ca/legal-services/sites/default/files/teams/1/Policies-Student-Accommodation-Policy.pdf>

Students needing an accommodation because of a disability or medical condition should communicate this need to Student Accessibility Services in accordance with the Procedure for Accommodations for Students with Disabilities: <https://www.ucalgary.ca/legal-services/sites/default/files/teams/1/Policies-Accommodation-for-Students-with-Disabilities-Procedure.pdf>.

Students needing an accommodation in relation to their coursework or to fulfil requirements for a graduate degree, based on a Protected Ground other than Disability, should communicate this need, by filling out the [Request for Academic Accommodation Form](#) and sending it to Dr. David Feder by email phas.ahugrd@ucalgary.ca preferably 10 business days before the due date of an assessment or scheduled absence.

- f. **Freedom of Information and Privacy:** This course is conducted in accordance with the Freedom of Information and Protection of Privacy Act (FOIPP). Students should identify themselves on all written work by placing their name on the front page and their ID number on each subsequent page. For more information, see [Legal Services](#) website.
- g. **Student Union Information:** [SU contact](#), Email SU Science Rep: sciencerep1@su.ucalgary.ca, [Student Ombudsman](#)
- h. **Surveys:** At the University of Calgary, feedback through the Universal Student Ratings of Instruction ([USRI](#)) survey and the Faculty of Science Teaching Feedback form provides valuable information to help with evaluating instruction, enhancing learning and teaching, and selecting courses. Your responses make a difference - please participate in these surveys.
- i. **Copyright of Course Materials:** All course materials (including those posted on the course D2L site, a course website, or used in any teaching activity such as (but not limited to) examinations, quizzes, assignments, laboratory manuals, lecture slides or lecture materials and other course notes) are protected by law. These materials are for the sole use of students registered in this course and must not be redistributed. Sharing these materials with anyone else would be a breach of the terms and conditions governing student access to D2L, as well as a violation of the copyright in these materials, and may be pursued as a case of student academic or [non-academic misconduct](#), in addition to any other remedies available at law.

Schedule of topics

Schedule is approximate and may be adjusted depending on progress and feedback.

Lecture component - Wed & Fri classes:

Week 1: Lecture 1-2 (Sep 7, 9)

Introduction and review of syllabus

Symmetries and conservation laws – Chapter 6.1-4

Week 2: Lectures 3-4 (Sep 14, 16)

Symmetries, degeneracy, and selection rules – Chapter 6.5-7

Week 3: Lectures 5-6 (Sep 21, 23)

Time translation and Heisenberg picture – Chapter 6.8

Week 4: Lectures 7-8 (Sep 28, 30)

Perturbation theory (non-degenerate and degenerate) – Chapter 7.1-2

Week 5: Lectures 9-10 (Oct 5, 7)

Fine structure and hyperfine splitting – Chapter 7.3 and 5

Week 6: Lecture 11-12 (Oct 12, 14)

Variational principle and application to molecules – Chapter 8.1-3

Week 7: Lecture 13-14 (Oct 19, 21)

Molecular orbitals and valence bonds – Chapter 8.4 and notes

Vibrational and rotational energies – notes

Week 8: Lecture 15-16 (Oct 26, 28)

WKB approximation – Chapter 9.1-2

Week 9: Lecture 17-18 (Nov 2, 4)

Time-dependent perturbation theory – Chapter 11.1

Interaction with E.M. waves – Chapter 11.2

Week 10: Term-break/reading week**Week 11: Lecture 19-20 (Nov 16, 17)**

Incoherent EM interaction and Einstein A and B coefficients – Chapter 11.3

Fermi's golden rule and adiabatic approximation – Chapter 11.4

Week 12: Lecture 21-22 (Nov 23, 25)

Pure and mixed states – Chapter 12.1

Entanglement and Bell's theorem – Chapter 12.2

Week 13: Lecture 23 (Nov 28 - Monday)

Advanced topics (e.g. quantum information, laser cooling and trapping, ...)

Nov. 30, Dec. 2, 5, and 7

PHASQ22 conference & Quantum Science lab tours

Course incomes

Ability to solve differential equations, perform basic matrix/vector operations. Understanding of eigenvectors and eigenvalues. Comfortable working with complex numbers (including complex exponentials). Familiarity with basics of modern physics – atoms, photons and electrons, Coulombs Law, electric potential and other concepts of electromagnetism. Understanding of wavefunctions, the Schrödinger equation, Dirac notation, and Hilbert space.

Course Outcomes:

- Use various perturbation and approximation approaches in quantum mechanics to explain and derive a number of phenomena, e.g. fine and hyperfine structure of atoms and Zeeman splitting.
- Apply scattering theory and understand its consequences under a range of experimental conditions
- Have a broad understanding of the interaction between electromagnetic radiation and atomic quantum systems and be able to address a number of practical applications.
- Address qualitatively and quantitatively how quantum mechanics relates to a number of common technologies and phenomena.

Electronically Approved - Aug 29 2022 13:59

Department Approval